other places where runoff has been concentrated and the conveyance system is not adequately protected to resist erosion.

Applicability

For all land disturbance activities erosion and sedimentation controls are to be implemented to prevent excessive sediment transport via stormwater runoff. After construction, it is important that property owners periodically inspect the facility grounds to check for any erosion problems or areas where earth is exposed due to poor grass cover or landscape cover.

City of Greensboro Soil Erosion and Sedimentation Control

Through the Soil Erosion and Sedimentation Control Act of 1973 and the City's National Pollution Discharge Elimination System (NPDES) Stormwater Permit, the City of Greensboro enforces sedimentation and erosion controls on all new commercial and residential projects. For sites where land disturbances are greater than one (1) acre, a grading permit is required by City Ordinance. For sites where land disturbances are less than one (1) acre, no grading permit is required; however, the City will still manage and enforce erosion control on the site.

Refer to the City's Soil and Sedimentation Control Section Standards of Practice for more information on the City's regulations, policies, and procedures. Or, contact the Field Services Section of the Storm Water Services Division at 373-2812.

3.3 Non-Structural BMPs

3.3.1 Open Vegetated Conveyance

Description

Open vegetated conveyances may be used instead of curb and gutter (where permitted) and hard piping to convey stormwater runoff where feasible. Open vegetative conveyances may be channels, swales, and, where runoff is in the form of sheet flow, any vegetated area that accepts runoff. Vegetated conveyances help to improve water quality by providing partial pollutant removal as the water is filtered by the vegetation and an opportunity for a portion of the water to infiltrate into the soil. They can also improve stormwater runoff quantity management by reducing the velocity of the flow through the conveyance and providing some infiltration into the soil.

Applicability

Vegetated conveyance systems can best be incorporated into moderate to low density development where land area is available and where the land surface is gently sloping (5% maximum). The site soils must be able to withstand erosion and a dense cover of strong rooted

vegetation, such as tall fescue grass, must be established within the conveyance. Vegetated conveyances usually work best when the conveyance is "cut" into existing soils.

A benefit of using open vegetated conveyances is that they can save on construction costs by eliminating the need for stormwater sewer systems.

Open vegetated conveyances may be used for the following:

- ⇨ *Stormwater conveyance in the watershed critical area.* Section 30-7-3.2 (2) (a) states that drainage shall be provided by means of open channels. Subsection (b) states that the drainage shall have protected channels.

- ⇨ *Scoring points on the "scoresheet" for low density development in the General water-supply watershed area.* Use of open vegetated conveyances will provide more points than piped conveyances (Factor #10). Also, vegetated conveyances that are used and are designed to resist soil erosion (10-year event), will classify as "protected drainageways" on the scoresheet (Factor #5).

- ⇨ *To provide stormwater quantity control.* Vegetated conveyance systems can provide temporary retention to reduce stormwater discharge rates. A hydrologic-hydraulic analysis will have to be performed to determine the design that will provide the desired reduction (for more information on design guidelines, see Section 3.4.6, Grass Swales, and section 3.4.7, Filter Strips).

- ⇨ *Credit towards the stormwater utility fee.* Using vegetated conveyances instead of "hard" conveyances and are designed according to the guidelines given below, will be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

Planning and Design Guidelines

To improve its effectiveness as a stormwater BMP, open vegetated conveyance systems should be used in gently sloping areas to promote shallow, low velocity flow. This will maximize the channel filtering surface, and facilitate sedimentation and infiltration while increasing the travel time to the discharge point.

Channels and swales should be designed to promote shallow flow (i.e. trapezoidal). Conveyances designed with narrow cross sections will have higher velocities and deeper flow depths which allows for less pollutant removal, increased erosion potential, and higher quantity of flow at the discharge point.

The bottom width should be wide enough to maintain a shallow flow but narrow enough to prevent small rills from forming in the bottom during low flows.

Generally the side slopes should not be steeper than 3H:1V. The slopes should be flat enough to maximize the contact surface area (the water with vegetation) and prevent bank erosion while steep enough to reasonably contain the flow.

The permissible velocity for vegetated conveyances should be limited to prevent erosion within the channel. The permissible velocity varies depending on the soil type, the vegetation type, how well the conveyance is maintained, etc. Generally, the velocity should not exceed 4 ft/sec within the channel (10 year storm), for velocities greater than this, check dams may need to be constructed within the channel to slow the velocity.

It is recommended that the lining of open conveyances be a dense cover of erosion resistant grass, such as tall fescue. For channels and swales where relatively steep slopes exist (greater than 3:1), it may be beneficial to plant trees along the top of the slope. Tree roots will provide additional stabilization to the channel banks. It may be necessary to use temporary matting to get the grass established or to use sod.

3.3.2 Stream Buffers

Description

Stream buffers may be implemented along streams, drainageways, and impoundments. The function of the buffers are to:

- ⇨ protect the overall stream quality by providing shading for the stream and provide wildlife habitat;
- ⇨ remove pollutants from stormwater runoff through infiltration and filtering of stormwater runoff from adjacent land areas;
- ⇨ help attenuate flow rates from developed areas;
- ⇨ provide a set back from the stream to prevent damage to structures or improved property due to flooding or changes in the stream channel.

The most effective stream buffers for protecting the overall quality of the stream are those that are left undisturbed including a tree line maintained along the stream bank.

Applicability

All major streams, drainageways, and water bodies should have buffer protection.

Stream buffers must be provided for the following:

Meet water-supply watershed and stormwater management requirements. Refer to Section 2.3 of this Manual for more information.

Stream buffers may be provided for the following:

- ⇨ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points on the scoresheet can be granted for buffers placed on drainageways and jurisdictional streams (Factor #7).

- ⇨ *Reduce the stormwater runoff that a site generates.* Stream buffers can serve to reduce the runoff rates that flow into the buffer. The actual reduction depends of the quantity of flow entering the buffer, the flow source (e.g. pipe discharge, sheet flow), the width of the buffer, buffer ground cover, etc.

- ⇨ *Credit towards the stormwater utility fee.* Properties that implement stream buffers according to City requirements and the guidelines below will be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

Planning Design Guidelines and Requirements

Stream buffers, at a minimum, are required to be implemented on both sides of (1) perennial streams, as defined by this Manual, and (2) drainage channels draining an area equal to or larger than 50 acres. In the Randleman Lake Watershed, buffers on intermittent streams are required as well.

3.3.3 Disconnect Rooftop Drainage

Description

Disconnecting rooftop drainage can reduce the runoff flow rates from developed areas. Disconnecting means that runoff from rooftops will not be directed to storm drainage systems but rather be directed toward pervious surfaces where it can filter through the grass or other landscape material, or infiltrate into the soil.

Applicability

This practice is applicable mostly for low density residential or commercial developments (less than 50% impervious). Disconnection is not applicable where the volume of runoff from rooftops will cause erosion or problems to adjacent downstream properties.

Disconnection practices may be used for the following:

- ⇨ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points on the scoresheet can be granted for dispersing flow instead of concentrating it (Factor #5). To receive points, the rooftop should disconnected as specified below (along with other impervious areas).

⇨ *Provide stormwater quantity control.* Disconnection of impervious areas can increase the time it takes for runoff to travel to the site outfall (increase time of concentration) and may allow a portion of the runoff to infiltrate into the soil. The effect that disconnection has on stormwater quantity depends on many factors, such as the storm event, the amount of impervious area that is being disconnected, whether the flow is concentrated or not, the soil type, the type of cover on the pervious surface, and the distance from where the runoff is "disconnected" to the nearest downstream area of imperviousness, stormwater conveyance system, or site outfall.

⇨ *Credit towards the stormwater utility fee.* Properties that disconnect rooftop drainage according to the guidelines below, will be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

Planning and Design Guidelines

Downspouts from rooftops should discharge to gently sloping, well vegetated or landscaped areas (mulched areas do a good job in storing and dispersing water as long as the inflow velocity is not great). Erosion control devices, such as splash blocks may be needed at the roof downspout discharge.

Rooftops should provide a downspout for every 5000 square feet of rooftop to reduce the erosion potential at the discharge location. The minimum distance between downspout discharge and the next impervious surface shall be 10 feet.

3.3.4 Clustering/Conservation of Natural Areas

Description

Clustering is a land development practice which can be implemented to concentrate development away from environmentally sensitive areas such as streams, wetlands, mature forests, etc. Because the idea of clustering is to compact development in one location, it will also reduce the amount of roadways, sidewalks and drives required compared to development that sprawls over the entire land area.

Applicability

Clustering and conversation of natural areas should be practiced at least to some extent for all developments, not only to reduce the impacts to our natural resources by minimizing disturbance and percentage impervious, but also to maintain some of the natural beauty of the site.

Clustering and conservation may be used for the following:

⇨ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points for clustering (Factor #1) can be received based on the criteria listed

in the water-supply watershed ordinance (Chapter 30). Points can also be earned for conservation of stream buffers (Factor #7) and for conservation or re-creation of wooded areas (Factor #11). Also, by reducing built-upon surfaces, points may be gained for built-upon area (Factor #2).

⇨ *Protection of fragile areas in the watershed critical area.* The City ordinance requires development to conserve fragile areas in the undisturbed state. Fragile areas are steep slopes (>15%) lying adjacent and parallel to streams and drainageways, and wetlands.

⇨ *Reduction of stormwater utility fee.* Clustering and conservation practices are designed to reduce the impervious areas required for the site. Because the stormwater utility is based on impervious surfaces, the fee will be reduced for the site.

⇨ *Other considerations.* Reducing the amount of impervious area reduces the volume of runoff required to be treated by structural BMPs thus reducing the cost and size of the BMPs. Concentrating development away from environmentally sensitive areas will also reduce the amount of time and expense to get federal and state permits for impacts to jurisdictional waters.

Planning and Design Considerations

Concentrate development on the flattest part of the land away from environmentally sensitive areas such as steep slopes, streams, and wetlands. This will not only reduce the impacts to these areas but may reduce the amount of earth moving necessary.

Minimize the width of streets (in accordance with City standards).

Minimize the number of parking spaces and reduce the size of parking stalls and parking aisle widths (in accordance with City standards).

Reduce the amount of overflow parking to the minimum needed.

Take inventory and preserve mature trees and forests.

3.3.5 Grass Paving

Description

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used such as fire lanes, overflow parking, golf cart paths, etc. A variety of grass paving units are available on the market. Grass paving units are designed to carry vehicular loading and may be composed of different type materials. The pavers are usually covered with sod to make these areas practically indistinguishable from other grassed areas.

Grass paving provides water quality benefits by allowing stormwater to infiltrate into the underlying soils and by filtering of the stormwater as it flows through the grass.

Applicability

Grass pavers can provide a more aesthetically pleasing site and reduce the "sea of asphalt" look. Grass paving should not be used for frequently traveled or parked in areas, since damage could be done to the grass and the grass needs sunlight to survive.

Grass paving may be used for the following:

- ⇨ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points can be received for "Other Measures" (Factor #12) for use of grass paving. Sites that incorporate 5% of their total impervious surface as grass paving will receive 10 points for this category.

- ⇨ *Reduce the runoff generated by a site.* Grass pavers can reduce the runoff volume generated and extend the time of concentration. Some units may provide enough infiltration to be considered a pervious cover; check with the manufacturer for more information on the runoff characteristics of the grass paving.

- ⇨ *Reduction of stormwater utility fee.* Grass paving is not considered an impervious surface (see note below) as it pertains to the fee, therefore the fee will be less.

- ⇨ *Credit towards the stormwater utility fee.* Sites that incorporate grass paving into their site, will be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

*Note: Grass paving units are considered by the State and the City to be built-upon area, as it pertains to water-supply watershed regulations.

Design Considerations

Grass paving should not be used in high traffic areas or where vehicles will be permanently parked for long periods of time which may affect the growth of grass.

Refer to the manufacturer's guidelines for proper design considerations, installation, and maintenance of grass paving.

3.3.6 Natural Infiltration

Description

Natural infiltration is a method in which an undisturbed land area covered with natural vegetation accepts runoff from new development and infiltrates the runoff into the soil. Natural

infiltration areas should only be used where the soils have a moderate to high infiltration rate (that is, soils in hydrologic group A or B). The area should be in the forested condition with the land surface covered by leaves, needles, and organic matter and should only be used for passive recreation, such as hiking.

Applicability

A natural infiltration area, that meets the design criteria below, may be used a stormwater quality control in the Watershed Critical Area (WCA) where the built-upon area is 6% or less in the Lower Randleman WCA or is 12% or less in any other WCA.

Design Considerations

The following equation is to be used to determine the size of the natural infiltration area (Source: Guilford County Water Quality Protection Manual):

$$\mathbf{A = (KTI)/[(cd – K)}$$

Where

A = Natural infiltration area required
K = 0.5 (runoff, inches)
T = Site area
I = Built-upon area ratio (Built-upon area/T)
c = Effective water capacity, in./in. (water/soil)
d = Depth of soil A horizon, in. (determined from table 3.2)

TABLE 3.2: SUITABLE SOIL TYPES FOR NATURAL INFILTRATION

SOIL TYPE	c in/in	d in	HYDROLOGIC GROUP
Appling sandy loam	.25	6	B
Cecil, Madison sandy loam	.25	4	B
Enon, Vance, Helena, fine sandy loam and sandy loam	.17	4	B
Cecil, Enon, Madison, Coronaca and Mecklenburg sandy clay loam and clay loam	.14	4	B or C

SOURCE: GUILFORD COUNTY WATER QUALITY PROTECTION MANUAL

The runoff from areas to be treated should flow into the natural infiltration area as sheet flow and with a non-erosive velocity.

The natural infiltration area is to have the following characteristics:

1. Appropriate soils – high or moderate infiltration rates, low erosion potential, well drained (not in wetland or floodplain)

2. Mature forest cover (the calculated natural infiltration area (A) is to be doubled where a mature forest cover is not present)

3. Slopes not exceeding 10% (where slope exceeds 10% an additional 10% is to be added to the calculated natural infiltration area (A))

4. Remain permanently undisturbed – the natural infiltration area is to be covered by a water quality conservation easement (WQCE)